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ABSTRACT

The purpose of this study was to identify features of young children's behavior that contribute to effective problem solving. A total of 24 children 4 and 5 years of age, half from low socioeconomic status (SES) families and half from high, were observed while performing perceptual/performance cognitive tasks. Five tasks were presented. All test sessions were videotaped, and observers coded behavior using a continuous time sampling procedure. Three mutually exclusive state codes measured duration of behavior; these were attention, attention and on-task manipulation, and off-task behavior. Five event codes measured task talk, visual scanning, trial and error responding, impulsive responding, and helpless confirmation seeking. Frequency of behavior that reflected problem solving strategies was recorded. Findings revealed that two of the behavior categories, "helpless confirmation seeking" and "task talk," were associated with 77 percent of the variance in test performance. Significant SES differences were found in all of the five categories of observed behavior, except "task talk." Results are discussed in terms of functional variables that are responsible for SES differences in performance.(RH)

ALTERNATIVE ASSESSMENTS OF HANDICAPPED CHILDREN

A Series of Technical Reports and Working Papers

Technical Report No. 1

Young Children's Problem-Solving Strategies: An Observational Study

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Young Children's Problem Solving Strategies:

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ABSTRACT

The purpose of this study was to identify features of young children's behavior that contribute to effective problem solving. Twenty-four 4- and 5-year old children, half from low SES families and half from high SES families, were observed while performing perceptual/performance cognitive tasks. Frequency of behavior that reflected problem solving strategies was recorded. Results are discussed in terms of functional variables that are responsible for SES differences in performance. Two of the behavior categories were associated with 77% of the variance in test performance. Significant SES differences were found in 4 of the 5 categories of observed behavior.

The circumstances that affect a child's experiences in the course of growing up play an important role in the development of intelligence, motivation, and competence (Hunt, 1972; Gordon & Shipman, 1979; Sternberg & Powell, 1984). Children from lower socioeconomic status (SES) families often have lower scores on school achievement and intelligence tests than higher SES children (Matlin & Albizu-Miranda, 1970) and they often fail in school. The physical and social environment that lower SES children experience may not be sufficient to promote development of their intellectual potential (Heath, 1982; Hess & Shipman, 1965; 1968; Loasa, 1980; Tizard, Hughes, Pinkerton & Carmichael, 1982).

Several theorists have suggested that adequate cognitive development is dependent upon children's acquisition and use of effective cognitive strategies (Feuerstein, Rand, and Hoffman, 1979; Brown & DeLoache, 1978; Kagan, 1965; Santostefano, 1978). The rate of acquisition of cognitive strategies and the opportunity to use these cognitive strategies may differ in the higher and lower SES environments. SES differences in cognitive development may, therefore, be a reflection of the children's effective or ineffective use of cognitive strategies.

Feuerstein et al. (1979) have listed cognitive functions that are necessary to find, elaborate and report information effectively (e.g., systematic planning, comparative behavior)(also see Haywood, 1977); Kagan (1965) has explored cognitive styles (e.g., impulsivity-reflectivity); Santostefano (1978) has proposed cognitive controls (e.g., body tempo, focal attention); Brown and DeLoache

(1978) have studied self-regulatory skills needed for efficient problem solving (also see Brown, Bransford, Ferrara, & Campione, 1984; Flavell, 1979). A comparison of the work of these authors reveals clear differences in their definitions of cognitive variables. For example, Feuerstein et al. (1979) define a cognitive function as a mode of thinking that underlies internalized, representational, and operational thought. Kagan (1965), on the other hand, defines cognitive style as a child's consistent tendency to display a certain type of behavior in problem solving situations. What they all share, however, is the common goal of identifying aspects of the thinking processes that underlie effective learning and problem solving.

In this paper, we define a cognitive strategy as a routine set of procedures that can be used to achieve a particular goal across a range of problem domains (Brown et al., 1984; Burns & Vye, 1984). Examples of effective cognitive strategies are: (a) identifying the existence of a problem; (b) systematically searching materials; (c) comparing several pieces of information; and (d) checking one's answers (also see Bransford & Stein, 1984). Based on the discussion above, we would expect that upper SES children would have been educated to use these more effective strategies on tasks like those included in intelligence tests.

The purpose of this study was to examine the cognitive strategies of young children and to specify some of the psychological variables that may account for IQ differences among SES groups. An observational format was used to address two questions: (1) are cognitive strategies related to children's performance on cognitive

tasks within the perceptual performance domain; and (2) are there differences in strategy use between lower and higher SES groups.

It was expected that: (a) cognitive strategies would be related to task performance and (b) high SES children would use more effective cognitive strategies than would low SES children. For example, high SES children were expected to attend to the task and compare their answers to a model to check for accuracy, while low SES children were expected to use trial and error problem solving methods and to neglect checking their answers.

Method

Participants

Participants were 24 four- and five-year-old children who attended preschool educational or day-care programs. Children were recruited from preschool programs in the Metropolitan Nashville area many of which provided services for both lower and higher income children. Children identified as having visual, hearing, and/or perceptual problems, and children identified as mentally retarded, were not included in this study. Twelve children were from low-income families and 12 were from middle- to upper-income families. The scale by McCorkel and May (1971), which is used to examine economic level, parent education, and parent occupation in determining SES, was used to verify SES. Six children in each group were black and the other six were white. Three of the black children and three of the white children in each group were female and three of each race were male. There was a significant SES difference between the low and high income groups, $F = 55.60$, $P < .001$, but no main effects for SES differences within race or sex groups.

Materials

Several perceptual performance items from intelligence tests were selected. The items chosen: a) were designed for children at or slightly above the participants' chronological age; b) facilitated a minimal level of verbalization needed for successful performance; and (c) required the use of general cognitive strategies such as systematic exploration, comparative behavior, precision and accuracy, and restraining of impulsive behavior for successful performance.

The test items were:

1. The Animal House subtest from the Wechsler Preschool and Primary Scale of Intelligence (Wechsler, 1967). In this task, children are asked to match colored pegs with particular animals. Skills needed for successful performance include differentiating and matching colors and animals.h
2. Raven's Coloured Progressive Matrices, series A pages 1-10 (Raven, 1960). In this task, children are asked to complete a pattern by selecting a missing piece of the pattern. Skills needed for success are differentiating colors and shapes, matching colors, shapes, and number, early counting, and considering more than one piece of information at a time.
3. An adaptation of the Stencil Design Test of the Arthur Point Scale of Performance Tests (Arthur, 1945) which consisted of 8, two-stencil items. In this task children have to select two cards out of 18 to make a picture that looks like a model. Skills include differentiating and matching colors and shapes, and considering more than one piece of information at a time.
4. An adaptation of the Block Design subtest from the Hiskey-Nebraska Test of Learning Aptitudes (Hiskey, 1966). The first five designs were used along with four new designs. In this task children match block designs to line drawn picture models.

Early spatial and counting skills are needed in order to complete this task.

5. The Conceptual Groupings subtest from the McCarthy Scales of Children's Abilities (McCarthy, 1972). In this task children categorize blocks by shape and color and combinations of these. Skills involved include discriminating attributes and considering more than one attribute at a time.

Procedure

Children were tested individually in a small room in their school building. All sessions were videotaped. Video equipment was in the testing room. The experimenter showed the video equipment to the child and explained that it would take a picture of the child. Initially, the child was given some coloring activities to do in order to get him or her familiar with the testing situation and the video.

The five tasks were then presented in the order of their listing in the materials section. Tasks were introduced using the standard procedures provided in the test manual. The session lasted approximately 30 minutes. While the child was working, the experimenter responded with an "okay" after each item in the task. At the end of each test the child was told "good." After performing all the tasks, the child was told that he/she did very well.

Coding Tapes

A coding system was developed based on previous research (Cohen & Stearn, 1978; Feuerstein et al., 1979; Forness & Guthrie, 1977; Sigel, 1974; Simon, 1970) and the observations by the experimenter and a naive observer of 11 pilot tapes. The pilot tapes were of eight lower SES and three higher SES children who attended preschool.

Observers coded behavior from the videotapes using a continuous time sampling procedure (Sackett, 1978). One observer did not know the children's SES. Three mutually exclusive state codes measured duration of behavior. The state codes are:

1. Attention - looks at experimenter or materials during instructions and/or looks at materials while performing.
2. Attention & On-Task Manipulation - active contact, using hands, with the materials that the child is working with. This is applicable only when it is time to be manipulating materials.
3. Off-Task Behavior - active contact, using hands, on the environment or body that is not part of the material in the study. This includes manipulating task materials when the child should be listening to instructions.

Event codes (Altman, 1974) were recorded at the onset of the behavior and only their frequency (i.e., not duration) was recorded in this study. The event codes are:

1. Task Talk - child explains what he/she is going to do before performing the task and/or explains intermediate steps. Child talks in general about the task.
2. Visual Scanning - child looks at model or head moves past the center line (imaginary) dividing the left and right sides of the materials.
3. Trial and Error Responding - the number of stencils that the child touches that are not a part of the model design that is being made. Child changes answer.
4. Impulsive Responding - child speaks, gestures, or starts the task before the instructions are finished. When making a block design the child uses all nine blocks, even though none of the designs required using all of the blocks.
5. Helpless Confirmation Seeking - child looks to the tester while using the task materials or asks for help in a non-specific request.

Test Data

Children's total perceptual/performance test score was calculated by summing the number of items correct across all tasks.

Reliability

Inter-rater reliability for 10 of the behavior categories was determined using the Pearson Product-Moment Correlation Coefficient for behavior frequency and duration in seconds. Inter-rater reliability was established on 11 of the children in the study, 6 at the beginning and 5 at the end. Six of the reliability tapes were of lower SES children and 5 were of higher SES children. The median inter-rater reliability coefficient was .93 with a range of .79 to .98.

Results

As would be expected from earlier studies on IQ differences between SES groups, a significant test score (test score range is from 18 to 43 points) difference was found between the SES groups ($F = 11.61$, $p < .01$), with the higher SES group performing more accurately. When the five behavior categories that reflected cognitive strategies were entered into a stepwise regression analysis in which the test score was the criterion variable, two of the behavior categories added significantly to the model. With these two categories, "Helpless Confirmation Seeking" and "Task Talk", an R-squared of .77 was obtained (adjusted R square of .75). Thus 77% of the total variance in the test scores was associated with these two behavior categories.

T-tests were used to examine differences between the two SES groups (see Table 1). A MANOVA analysis was not used because with one-tailed tests, this analysis could result in loss of power (Tabachnick & Fidell, 1983). Children were engaged in on-task behavior (i.e., "Attention" and "On-Task Manipulation") about 90% of the time. No significant SES differences were found in the duration of "On-Task Behavior" and "Off-Task Behavior".

On the categories that reflected cognitive strategies, twenty of the children exhibited every behavior that was measured. Three children did not exhibit every behavior, that is, one low SES child did not exhibit any "Trial and Error Behavior", one high SES child did not exhibit any "Task Talk", and one other high SES child did not exhibit "Impulsive Responding" behavior. Significant differences were found between the two SES groups on 4 out of the 5 behavior

categories that reflected cognitive strategies. These were "Trial and Error Behavior" (t = 1.83, p < .05), "Impulsive Responding" (t = 2.10, p < .05), "Visual Scanning" (t = -2.20, p < .05) and "Helpless Confirmation Seeking" (t = 2.40, p < .05). No SES differences were found for "Task Talk".

Low SES children did not differ from high SES children in time spent on task. Nevertheless, the low SES children performed less effectively. They "scanned" the materials and looked at models fewer times than did the high SES children. Lower SES children were impulsive in their approach to the tasks, often beginning the task before the tester finished the instructions, and performed in an unplanned, trial and error fashion, seeming to be quite dependent on the tester.

Discussion

In this study, we identified features of children's problem solving ability which are related to intelligence test performance in the perceptual performance domain; some of the features are linked to SES differences and others are not. As would be expected from previous research (see Gordon & Shipman, 1979; Sternberg & Powell, 1984) SES differences were found in the children's test scores. Two of the behavior categories used in this study (i.e., "Task Talk" and "Confirmation Seeking") were associated with 77% of the variance in test scores.

Low SES children did not differ from high SES children in time spent on-task. Nevertheless, the low SES children performed less effectively. They "Visually Scanned" the materials and looked at models of what they were making fewer times than did higher SES children. They were also more likely to be "Impulsive" in their responding and they exhibited more "Trial and Error" behavior. These findings parallel those of Brown & DeLoache (1978) and Feuerstein et al. (1979) in their studies with older children. They suggest an unplanned approach to solving problems. Low SES children also sought "Confirmation" more often than did high SES children. This tendency indicated overdependence on the tester in the majority of cases.

Although "Task Talk" was a significant variable in the regression model, no statistically significant differences were found between SES groups. A high frequency of "Task Talk" indicates precision in planning and responding on a test item (Brown & DeLoache, 1978; Feuerstein et al., 1979) and is also related to

self-regulatory behavior (Meacham, 1978; Vygotsky, 1929; 1978; Wertsch, 1979).

In summary, in this study we identified behavior that related to test performance and found that some types of behavior differed as a function of SES. Status variables such as SES are not causal; rather, these behavior categories reflect functional psychological variables that are responsible for the obtained differences in test scores among various SES groups.

As noted by Jersild (1968) and Gordon and Shipman (1979) SES may correlate with test performance but such status characteristics are not the cause of ineffective cognitive strategies and poor test performance. Consider, for example, that low quality parent/child interaction is a possible cause of poor test performance. Even though SES and quality of parent/child interaction may be correlated, some lower SES children may have high quality parent/child interactions and some higher SES children may have low quality parent/child interactions. Therefore, some lower SES children might perform higher
than would be expected from SES alone and some higher SES chidren may perform lower than would be expected from SES.

The significance of the cognitive strategies identified in this study with regard to task performance has direct implications for instruction in preschools, especially for children in low SES groups who may be at risk for educational failure. These data suggest that instruction should include teaching cognitive strategies rather than teaching intelligence test items themselves, as is often the case in programs for high risk children. Also, it is important to consider

children's "On-Task" behavior. The children in this study were "On-Task" 90% of the time, but what each SES group did while "On-Task" was quite different. Therefore, when envisioning goals for increasing "On-Task" time in classrooms an additional level of analysis is needed, that is, teaching children to use effective cognitive strategies during their "On-Task" time.

TABLE 1

Means and T-Tests on Observed Behavior

Observed Behavior	Lower SES N = 12 Mean	Higher SES N = 12 Mean	t test	p
Attention	388.92	389.75	-.02	NS
On-Task Manipulation	496.75	510.50	-.18	NS
Off-Task Behavior	125.17	72.67	1.40	NS
Task Talk	8.58	9.58	-.25	NS
Trial and Error Behavior	20.00	9.50	1.83	.05
Impulsive Responding	6.08	2.50	2.10	.05
Visual Scanning	9.92	20.58	-2.20	.05
Helpless Confirmation Seeking	23.00	13.00	2.40	.05

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Footnotes

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